3KG1
Keypad Modules
CANopen

User Manual

Grayhill PN: 3KUM1331-1

Revisions

Revision	Description	Checked	Approved
A	ECN#384723 – BMM Original.	05/03/2011 RMO	05/03/2011 RAL
B	ECN#386037 – BMM Corrected TPDO parameter. RTR not supported.	10/26/2011 RMO	10/26/2011 RAL
C	ECN#408888 – BMM Removed support for 10kbps. Added appendix with “How To” examples.	12/14/2016 RMO	12/14/2016 RAL
D	ECN#508364 – DW Updated configurable parameter table. Updated user manual formatting throughout the document.	01/23/2024 JLF	01/23/2024 RAL

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Manual

1 Scope

This document describes the implementation of CANopen on the Grayhill standard CAN keypads designed for adherence to CIA Draft Standard 401.

2 Relevant Documents

- CIA Draft Standard 301, Application Layer and Communication Profile
- CIA Draft Standard 305, Layer Setting Services (LSS) and Protocols
- CIA Draft Standard 401, Device Profile for Generic I/O Modules

3 Product Validation

- Compliance shall be per CIA conformance test tool version 2.0.
- Grayhill CANopen vendor ID – 0307h.

4 Hardware Description

The Grayhill standard CAN keypads have buttons for inputs and indicator LEDs for outputs. The brightness of both the indicators and the backlights can be individually controlled.

The keypads will be designed to adhere to the CIA Draft Standard 401 for Generic I/O Modules.

4.1 Input

The keypads currently exist with 8, 12, 15, and 20 buttons. Each button will correspond to a digital input. A pressed/released button shall have a value of 1/0 respectively.

These inputs shall be transmitted using the default TPDO 1 as defined in CIA 401.

4.2 Outputs

Each button has three indicator LEDs associated with them. Each indicator can be controlled individually, and each will correspond to a digital output.

The indicators as a group and the backlights can have the brightness controlled. Both will be controlled using the default Analog Output entries as defined in CIA 401.

5 Object Dictionary (OD)

All the mandatory entries of the Object Dictionary (OD) as defined in CIA 301, 305 and 401 shall be implemented. The following is the list of the non-mandatory Object Dictionary entries that are implemented.

5.1 1000h – Device Type

Value = 000B0191h

This value indicates that the device is based on CIA standard 401, uses digital inputs, digital output, analog outputs, and is non-mappable. Refer to CIA v401 Sec 6.2.1

5.2 1001h – Error Register

The use of this register is not yet defined but is mandatory to be compliant.

5.3 1008h – Manufacturer Device Name

This is a visible string constant and gives the name of the device.

5.4 1009h – Manufacturer Hardware Version

This is a visible string constant and describes the version of the hardware.

5.5 100Ah – Manufacturer Software Version

This is a visible string constant and describes the version of the software.

5.6 1010h – Store Parameters

This entry will be used to store parameters pertaining to the communication device specific parameters as defined by CIA v301.

5.7 1011h – Load Parameters

This entry is used to load the parameters that were stored according to Sec. 5.6.

5.8 1017h* – Producer Heartbeat

5.9 1018h – Identity Object

Sub Entry:

- 00h – Number of Subentries. (4)
- 01h – Vendor ID 0307h
- 02h – Product Code 334Bh (ASCII 3K)
- 03h – Revision Number
- 04h – Serial Number

5.10 1400h* – 1st Receive PDO Communication Parameter

Default values as defined in CIA v401.

5.11 1401h – 2nd Receive PDO Communication Parameter

Default values as defined in CIA v401.

RTR Not supported.

5.12 1600h – 1st Receive PDO Mapping

Default values as defined in CIA v401.

5.13 1601h – 2nd Receive PDO Mapping

Default values as defined in CIA v401.

5.14 1800h* – 1st Transmit PDO Communication Parameter

Default values as defined in CIA v401.

5.15 1A00h – 1st Transmit PDO Mapping

5.16 2010h* – LED Scalars

Sub Entry:

- 00h – Number of entries
- 01h* – 8-bit unsigned value controlling the brightness of the backlights.
- Valid Range from 0 (off) to 255 (full illumination).
- 02h* – 8-bit unsigned value used as a scalar value for the full brightness. This value ranges from 64 (40h) to 255 (FFh) and can be thought of as the ratio of this number over 255. Ex. if 100% on is too bright (255/255) a value of 191 can be entered in this OD entry to scale the full range down to 75% (191/255).

5.17 6000h – Read Input 8-bit, Button Information

The buttons shall be treated as digital inputs. A button press shall register as logic ‘1’ and a release logic ‘0’. Each group of eight buttons will correspond to an 8-bit sub index starting with sub index 1. The top left button will correspond to the least significant bit of the byte value in sub index 1. The button to the right will correspond to the next and so on.

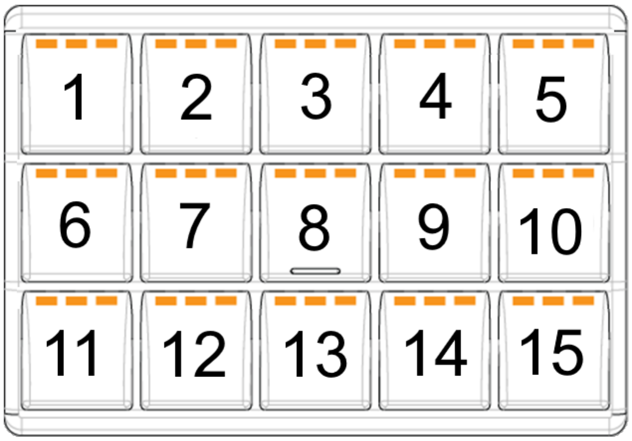

Figure 1 - Button Numbering Example

5.18 6200h – Digital Outputs, Indicators

The indicators shall be treated as digital outputs. Logic 1/0 turns the corresponding indicator on/off respectively. Each button has three corresponding indicators. NOTE: All three indicators are always referenced even though the indicator may not be present in the customer artwork.

Like the buttons, the indicators correspond with the left, topmost indicators to the least significant bit of the byte value of sub index 1. The next seven to the right correspond to the remaining bits. The right indicator of the third button, if it exists or not, corresponds to the least significant bit of the byte value in sub index 2. This continues right-to-left then top-to-bottom.

This entry shall not have the ability to store its current state in non-volatile memory.

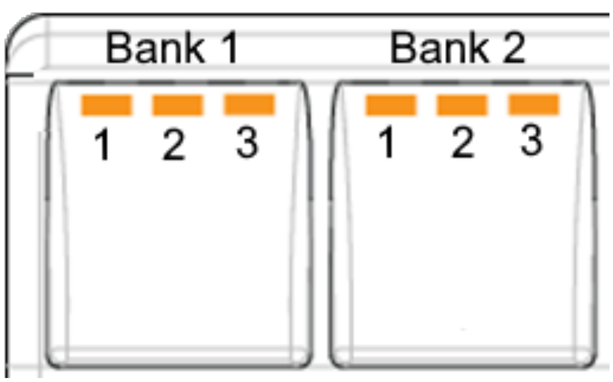

Figure 2 - Example LED address scheme

Example:
To turn the center LED of button one and the right most LED on button two; OD entry 6000sub01 would contain the value 0x22 (0b00100010). The two most significant bits are mapped to Bank 3 (not shown) LED’s 1 and 2.

5.19 6411h – Analog Outputs, Indicator and Backlight Brightness Control

Sub Entry:

- 00h – Number of Subentries.
- 01h* – Analog Output for Indicator Brightness: UNSIGNED16 with a range between 1 (dimmest) and 255 (full brightness).
- 02h* – Analog Output for Backlight Brightness: UNSIGNED16 with a range between 0 (off) and 255 (full brightness).

6 Process Data Objects (PDO)

6.1 RPDO

Two RPDO's exist that will control the indicators. One for controlling the state of each indicator and the other for controlling the brightness of the indicators as a group and the backlights. The indicator and backlight brightness can be controlled independently of each other.

6.1.1 RPDO1

OD 6000 is mapped to this RPDO and will be used to receive the digital input used for controlling the indicators. Eight sub-indexes for OD 6000, each of type UNSIGNED8, are used with each bit within the UNSIGNED8 controls a corresponding indicator. The bits in 6000sub01 are mapped to the first eight indicators on the keypad with the top, left most indicators controlled by the least significant bit. 6000sub02 then controls the next eight and so on until all indicators are accounted for.

6.1.2 RPDO2

OD 6411 is mapped to this RPDO and is used to control the brightness of the indicators as a whole and the backlights. 6411sub01 controls the indicators and 6411sub02 controls the backlights. Each is of type INTEGER16 but only the values from 0 to 255 are used. Any other value is ignored.

6.2 TPDO

One TPDO will be used to transmit the button information. Remote Transmit Request (RTR) will not be supported on the TPDO.

6.2.1 TPDO1

OD 6200 is mapped to this PDO and is used to transmit the button information. All three sub-indexes are mapped. The three interrupt mask OD entries, 6006, 6007 and 6008 are implemented for full control of when the PDO is transmitted. For consistency, the number of 8-bit button parameters is fixed at three, which will then be able to support up to 24 buttons total. If buttons are not present (an 8-position keypad for example) the corresponding values for the missing buttons shall read as zero.

6.3 PDO Mapping

The implementation of Dynamic Mapping is to be determined.

7 Layer Setting Services

The Grayhill keypads shall support the following baud rates.

- [0x00] 1000kbps
- [0x01] 800kbps
- [0x02] 500kbps
- [0x03] 250kbps
- [0x04] 125kbps
- [0x05] 100kbps
- [0x06] 50kbps
- [0x07] 20kbps

Note: 10kbps not supported

Using the LSS, the device shall have the ability to change the node ID and the baud according to CIA v305.

* Value is stored in non-volatile memory when the Store Parameters are performed for the Manufacturer Specific entries.

8 Grayhill CANopen Configuration Variables

Custom versions of our 3K product feature a customer-specific part number and allow factory configuration of numerous parameters. A description of parameters Grayhill can configure for custom part numbers appears below in table 1.

Field Name	Size (Bytes)	Range	Units	Default Value
Default Node ID	1	0x00 – 0x7F		0x0A
Baud Rate	1	0x00 – 0x07		0x03
Heartbeat Period	2	0x0000 – 0xFFFF	*1ms	0x00
COBID – RPDO1 (Indicator Control)	2	0x000 – 0x7FF		0x20A
COBID – RPDO2 (Backlight Control)	2	0x000 – 0x7FF		0x30A
COBID – TPDO1 (Button Data)	2	0x000 – 0x7FF		0x18A
Inhibit Time	2	0x0000 – 0xFFFF	*100µs	0x00
Event Time	2	0x0000 – 0xFFFF	*1ms	0x00
Indicator Brightness Scalar	1	0x00 – 0xFF		0xFF
Backlight Brightness Scalar	1	0x40 – 0xFF		0xFF
Indicator Brightness	1	0x01 – 0xFF		0xFF
Backlight Brightness	1	0x00 – 0xFF		0x00

Table 1 - Configurable Parameters

9 Appendix

9.1 Change Node ID

Changing the Node ID requires the use of the CANopen Layer Setting Services (LSS DS-305).

1. Put the device in STOP mode by sending the following
   ID = 000h, LEN=2, Data = {02h, 00h}
2. Send the Switch State Confide.
   ID = 7E5h, LEN=8, Data = {04h 01h 00h 00h 00h 00h 00h 00h}
3. Send the Change Node ID command.
   ID = 7E5h, LEN=8, Data = {11h 0Bh 00h 00h 00h 00h 00h 00h}
   The 2nd byte holds the value of the new node ID.
   This example sets it to 11 decimal (0x0B hex).
4. Send the command to store the new setting in EEPROM.
   ID= 7E5h LEN= 8 Data = {17h 00h 00h 00h 00h 00h 00h 00h}

9.2 Change COBID

1. Invalidate the current COBID by setting the most significant bit in OD entry 1800sub01. Replace xx with the current node ID. by default, it is 0Ah.
   ID = 6xxh, LEN = 8, Data = {23h 00h 18h 01h 00h 00h 00h 80h}
2. Writes the new COBID making sure the 31st bit is set signifying Remote Transmit Request is not supported. In this example, the COBID is changed from the default of 18Ah to 123h. Replace xx with the current node ID.
   ID = 6xxh, LEN = 8, Data = {23h 00h 18h 01h 23h 01h 00h 40h}
3. Store the new setting in non-volatile memory (EEPROM). Writes 'save' to OD entry 1010sub01.
   ID = 6xxh, LEN = 8, Data = {23h 10h 10h 01h 73h 61h 76h 65h}

9.3 Change Baud Rate

1. Put the device in STOP mode by sending the following:
   ID = 000h, LEN=2, Data = {02h, 00h}
2. Send the Switch State Config message:
   ID = 7E5h, LEN=8, Data = {04h 01h 00h 00h 00h 00h 00h 00h}
3. Send the Change Baud command:
   ID = 7E5h, LEN=8, Data = {13h 00h <id> 00h 00h 00h 00h 00h}
   The <id> field holds the baud ID as defined in CiA-305
4. Send the command to store the new setting in EEPROM.
   ID= 7E5h LEN= 8 Data = {17h 00h 00h 00h 00h 00h 00h 00h}

At this point you can simply cycle power to the device since the new settings are stored. The legitimate way is to then send the Activate Bit Timing command. There is a field in this command that specifies the amount of time to allow all devices to change to the new baud, usually a second. Then, the Switch State Wait command is sent and finally all devices are put in RUN mode.